1. The mutual intensity of an optical wave at points on the x-axis is given by:
\[ G(x_1, x_2) = I_0 \exp\left[ -\frac{x_1^2 + x_2^2}{W_0^2} \right] \exp\left[ -\frac{(x_1-x_2)^2}{L_c^2} \right] \]
where \( I_0, W_0, L_c \) are constants. Sketch the intensity distribution as a function of \( x \). Derive an expression for the normalized mutual intensity \( g(x_1, x_2) \) and sketch it as a function of \( x_1-x_2 \). What is the physical meaning of the parameters \( I_0, W_0, \) and \( L_c \)?

2. Show that light of narrow spectral width has a coherence length \( L_c \approx \lambda^2/\Delta \lambda \), where \( \Delta \lambda \) is the linewidth in wavelength units. Show that for light of broad uniform spectrum extending from wavelength \( \lambda_{\text{min}} \) to \( \lambda_{\text{max}} = 2\lambda_{\text{min}} \), the coherence length \( L_c \approx 1/2 \lambda_{\text{min}} \).

3. Light from a Sodium lamp of Lorentzian linewidth (FWHM) \( \frac{\Delta \omega}{\Delta \lambda} = 5 \times 10^7 \) Hz is used in a Michelson interferometer. Sketch the resulting interferogram. What is the maximum path-length difference for which the visibility of the interferogram \( > \frac{1}{2} \).

4. A spatially incoherent quasi-monochromatic source emits light. Light emits only at two points separated by a distance \( 2a \). Determine for the normalized mutual coherence at a distance \( d \) from the source (in the Fraunhofer regime).